IN THE UNITED STATES

PATENT AND TRADEMARK OFFICE

APPLICANTS: Stanley T. Birchfield and Daniel K. Gillmor

APPLICATION NO.:

FILING DATE: August 2, 2001

TITLE: ACOUSTIC SOURCE LOCALIZATION SYSTEM AND METHOD

EXAMINER:

GROUP ART UNIT:

ATTY. DKT. NO.: 21938-05581

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner For Patents, Washington, DC 20231, on the date printed below:

Dated: August 2nd, 2001 By: [signature]

Edward A. Van Gieson, Reg. No.: 4,386

COMMISSIONER FOR PATENTS
WASHINGTON, DC 20231

PRELIMINARY AMENDMENT

Sir:

Prior to examination, please amend the above-referenced application as set forth below:

In the Specification:

Replace paragraph [0011] with the following:

--[0011] Conventional techniques to calculate the cross-correlation function do not permit the effects of noise and reverberation to be completely eliminated. For a source

signal *s(n)* propagating through a generic free space with noise, the signal $x_i(n)$ acquired by the *i*th microphone has been traditionally modeled as follows:

$$x_i(n) = g_i * s(n - \tau_i) + \xi_i(n),$$

where α_i is an attenuation factor due to propagation loss, τ_i is the propagation time and $\xi_i(n)$ is the additive noise and reverberation. Reverberation is the algebraic sum of all the echoes and can be a significant effect, particular in small, enclosed spaces, such as office environments and meeting rooms. There are several techniques commonly used to calculate the cross-correlation of the two signals of each microphone pair. The classical cross-correlation (CCC) function for each microphone pair, C_{ij}, can be expressed mathematically as $C_{12}(\tau) = x_1(n) * x_2(n) = \sum_n x_1(n) x_2(n - \tau)$. This is equivalent to $C_{12}(\tau) = F^{-1}\{X_1(f) X_2^*(f)\}$, where *F* denotes the Fourier transform. CCC requires the least computation of commonly used correlation techniques. However, in a typical office environment, reverberations from walls, furniture, and other objects broadens the correlation function, leading to potential errors in calculating the physical time delay from the peak of the cross-correlation function.--

Replace paragraph [0049] with the following:

--[0049] Figure 7A illustrates the geometry for calculating the error for non-coincident pairs for selecting an inappropriate distance to the acoustic source and FIG. 7B is a plot of the error versus the ratio ρ / d. The azimuthal error is bounded $(\hat{\rho} = \infty)$ by:

$$\phi - \hat{\phi} = 2\beta = 2\sin^{-1}\left(\frac{\varepsilon}{2\rho}\right) = 2\sin^{-1}\left(\frac{d}{\rho(4\sqrt{2})}\right).$$

REMARKS/ARGUMENTS

This is a preliminary amendment to the accompanying U.S. patent application entitled "ACOUSTIC SOURCE LOCALIZATION SYSTEM AND METHOD" filed on August 2, 2001, by Stanley T. Birchfield and Daniel K. Gillmor. In the filing of the instant case, Applicants discovered several typographical errors after execution of the Declaration. These include an extra "the" in one sentence and the use of a positive sign instead of a negative sign in one formula. Consequently, Applicants desire to correct these typographical errors simultaneously with the filing of the instant application.

Attached hereto is a marked-up version of the changes made to the specification by the current amendment. The attached page is captioned **"Version with markings to show changes made".**

Entry of the preliminary amendment prior to examination is respectfully requested.

Respectfully submitted,
BIRCHFIELD ET AL.

Dated: August 2, 2001

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

[0011] Conventional techniques to calculate the cross-correlation function do not permit the effects of noise and reverberation to be completely eliminated. For a source signal *s(n)* propagating through a generic free space with noise, the signal $x_i(n)$ acquired by the *i*th microphone has been traditionally modeled as follows:

$x_i(n) = g_i * s(n - \tau_i) + \xi_i(n),$

where α_i is an attenuation factor due to propagation loss, τ_i is the propagation time and $\xi_i(n)$ is the additive noise and reverberation. Reverberation is the algebraic sum of all the echoes and can be a significant effect, particular in small, enclosed spaces, such as office environments and meeting rooms. There are several techniques commonly used to calculate the cross-correlation of the two signals of each microphone pair. The classical cross-correlation (CCC) function for each microphone pair, C_{ij}, can be expressed mathematically as $C_{12}(\tau) = x_1(n) * x_2(n) = \sum_n x_1(n)x_2(n - [+]\tau)$. This is equivalent to $C_{12}(\tau) = F^{-1}\{X_1(f)X_2^*(f)\}$, where *F* denotes the Fourier transform. CCC requires the least computation of commonly used correlation techniques. However, in a typical office environment, reverberations from walls, furniture, and other objects broadens the correlation function, leading to potential errors in calculating the physical time delay from the peak of the cross-correlation function.

[0049] Figure 7A illustrates the geometry for calculating the error for non-coincident pairs for selecting an inappropriate distance to the acoustic source and FIG. 7B is a plot of the error versus the ratio ρ / d. The [the] azimuthal error is bounded $(\hat{\rho} = \infty)$ by["]<u>:</u>

$$\phi - \hat{\phi} = 2\beta = 2\sin^{-1}\left(\frac{\varepsilon}{2\rho}\right) = 2\sin^{-1}\left(\frac{d}{\rho(4\sqrt{2})}\right).$$